

A Quality Improvement Project to Improve First Case On-time Starts in the Pediatric Operating Room

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Abstract

Background: Delays in the operating room (OR) can lead to increased hospital costs as well as patient and provider dissatisfaction. Starting the first case on time in the OR can potentially prevent subsequent delays. We designed a quality improvement project to improve the first case on-time starts in the pediatric OR at a tertiary care children's hospital. **Methods:** Following the collection of baseline data, we formed an interdisciplinary team. We analyzed the causes of delay and used the Six Sigma methodology of Define, Measure, Analyze, Improve, and Control. We identified key drivers and implemented several low-cost interventions using Plan-Do-Study-Act cycles. Major interventions included preoperative care coordination, strategic staggering of OR cases, and introduction of "Wow Bucks" incentives. We monitored start times and the delay in minutes for all first cases weekly. The OR minutes saved per week were calculated and used to estimate cost savings. **Results:** We studied a total of 1981 first-start cases from May 2018 to October 2019. The first case on-time starts improved from 62% to 77% over the study period. There was a significant improvement in total minutes delayed for all the first cases from 197.9 minutes per week down to 133 minutes per week ($P < 0.05$). Estimated cost savings were \$4,023 per week due to improved OR utilization. **Conclusions:** A multidisciplinary collaborative team approach using quality improvement tools can improve on-time starts in the pediatric OR. (*Pediatr Qual Saf* 2020;4:e305; doi: 10.1097/pq9.0000000000000305; Published online June 24, 2020.)

INTRODUCTION

The operating room (OR) is an integral part of any children's hospital and is a significant contributor to hospital revenue.¹ However, the intense clinical activity, the number of trained personnel, and the multiple types of expensive equipment required for each OR case also generate high costs. OR inefficiency can lead to significant financial consequences as OR



minutes are among the most precious minutes in the hospital. The most widely accepted cost estimate of an OR minute is \$62 with a range of \$21–\$133.² Additionally, OR inefficiency can be a significant source of frustration for patients and healthcare providers.

Maximal OR utilization requires on-time starts for the first case, minimal turnover time between cases, and an accurate allotment of time per case. If the first case does not start on time, it has cascading effects leading to delays in subsequent cases and decreased efficiency throughout the day. Beginning the first case on-time in the OR is a complex process. It requires the patient, surgeon, anesthesiologist, and OR nurses to be physically present and prepared before the start time. Additionally, they must complete all preoperative assessments and prepare appropriate OR equipment. Delay in any of the above factors can cause a delay in starting the case on time.

Many studies have attempted to improve first case on-time starts by adding personnel, providing extra resources, or introducing positive or negative financial reinforcements.^{1,3–9} Most studies were performed in adult ORs. To our knowledge, only one involves a pediatric OR.¹ We aimed to increase the average rate of first case on-time starts per week from a baseline of 62%–75% over 52 weeks.

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METHODS

Context

Yale-New Haven Children's Hospital is a major tertiary care children's hospital in Connecticut. A total of 105 credentialed surgeons from both Yale School of Medicine and the greater community perform approximately 6,600 surgical procedures every year in 7 operating rooms. Thirty-one surgeons operate regularly, with each doing more than 60 cases per year. Fifteen anesthesiologists and a staff of approximately 50 nurses and technicians work in the pediatric ORs.

The first case start time is 7:30 AM on Mondays to Thursdays, and 8:30 AM on Fridays due to educational activities. As there are two anesthesiologists who each run two ORs, they start 2 out of 7 cases at 7:45 AM (8:45 AM on Fridays). We define the on-time start as a patient being in the OR within 5 minutes of the set start time (ie, before 7:35 AM for 7:30 AM start time). We consider the case delayed if the patient arrives in the OR more than 5 minutes after the start time, and document the causes of delay electronically. We monitor all data details on start times and delays in minutes.

Preoperative Process

Before the start of our project, there was a standardized preoperative process, and we monitored all the major steps via navigation boards on the electronic medical record system (Epic Systems, Verona, Wis.). Patients were expected to arrive 60 minutes before the scheduled operation and were assessed in the preoperative area by preoperative nurses, anesthesiologists, surgeons, and OR nurses. Surgeons completed medical history updates and consents, and nurses performed pregnancy testing in girls older than 10 years of age. The surgical site was marked, and the OR was prepared for the specific operation. Following the completion of all steps and electronic documentation by all OR personnel, the anesthesiologists took the patient to the OR.

Interventions

A quality improvement project was planned to improve on-time starts in the pediatric ORs and was started in May 2018 as the weekly on-time start percentage dropped to 47%. We assembled a task force, including a surgeon, an anesthesiologist, 2 OR nurse managers, and a quality improvement specialist. The senior leadership of the hospital supported this project, but there was no specific funding allocated.

We used quality improvement tools from Six Sigma, namely DMAIC (Define, Measure, Analyze, Improve, Control) and the model for improvement.³ In the "Define" phase, we agreed with the definition of the on-time start, as mentioned above. In the "Measure and Analyze" phases, we collected and analyzed the data for start times from the previous 12 months using the electronic database to determine the major causes of delays (Fig. 1). The

preoperative nurses noted the delays and documented the reasons for the delay in all cases except 27% in which the reason fields were left blank. The surgeon-related causes (24%) were delays in seeing patients in the pre-operative area and were noted by 47 surgeons. Only 2 surgeons caused the maximum number of delays (11 each) over the 12 months. Patient-related factors (20%) included late arrivals, fasting status, inability to obtain urine for pregnancy testing, and need for premedication with midazolam. To gain a better understanding of the causes of delay and to increase awareness of this project, a survey was given to all OR personnel asking about suggestions for interventions to improve on-time starts. We reviewed recurrent themes from 86 responses to plan interventions. We identified five key drivers (Fig. 2) of on-time starts: patient readiness in the preoperative area, surgical preoperative assessment, anesthesia preoperative assessment, timely paperwork completion, and OR equipment readiness. Based on these key drivers, we implemented the following 8 interventions in the "Improve" phase using Plan-Do-Study-Act cycles.

1. OR setup: In the preintervention period, the nurses set up the OR on a day before the first case on an inconsistent basis. Starting from August 2018, the nurses set up the OR on a day before the first case, and the OR nurse manager strictly enforced this policy.
2. Preoperative nursing: A postanesthesia care nurse was brought in the preoperative area as a facilitator for the first case for 30 minutes without the additional cost of extra nursing time in September 2018. The facilitator helped surgeons and anesthesiologists to complete their assessments efficiently. In the preoperative area, a dry-erase board was installed and updated daily with the names of preoperative nurses and the facilitator.
3. Strategic staggering of cases: As previously described, 5 OR cases start at 7:30 AM, and 2 other cases begin at 7:45 AM. Before this project, the anesthesiologists randomly assigned the cases that started later. From October 2018, an anesthesiologist reviewed the OR cases the day before and selected 2 specific cases to start at 7:45 AM rather than 7:30 AM. The cases selected were the longer, more complicated cases, or cases with multiple providers to allow for extra preparation time in the morning.
4. Gift vouchers: Gift vouchers in the form of "WowBucks" worth \$2 in our hospital cafeteria are traditionally given to nurses or physicians for going "above and beyond." The hospital charges the OR only \$3.04 for a pack of 50 "Wow Bucks" vouchers. Starting November 2018, the surgeon, anesthesiologist, resident anesthesiologist, scrub nurse, and technician teams that started the first case on time each received a "Wow Bucks" voucher the same

- morning every OR day during the project.
5. Work stations: The preoperative areas had 2 battery-powered computer stations in the hallway, which frequently lost charge and were unusable. We replaced these computers with plug-in stations in November 2018.
 6. Pregnancy testing: In the preintervention period, if patients were unable to give a urine sample for pregnancy testing, a blood test was sent to the central laboratory, which caused delays. In December 2018, a rapid pregnancy testing kit using a blood test was made available in the preoperative area to avoid these delays.
 7. Time awareness: A clock was mounted in the preoperative hallway for time awareness in December 2018.
 8. Surgeon notification: All surgeons began to receive an automated text message a day before the procedure with information on their first case, date, time, OR number, and a telephone number to call in the case of questions. This system was previously in place for adult ORs at our institution, and we implemented it in the pediatric OR in February 2019.

In the “control” phase, we ensured strict implementations of all interventions. All OR personnel, including surgeons, were updated periodically with project progress and results.

Data Analysis

We monitored the weekly data of on-time starts on an automated dashboard. The percent of on-time starts and the minutes delayed for all first cases were calculated from this data to compare the preintervention and postintervention periods. Weeks 1–11 (May 2018–August 2018) were the preintervention period, and weeks 39–75 (February 2019–October 2019) were the postintervention

period. We calculated the average minutes saved per week between the preintervention and postintervention periods to estimate cost savings. To determine the cost of an OR minute, we used a value of \$62/min, adapted from a previous study.²

A statistical process control *P* chart using Microsoft Excel QI Macros was used, following the 7-point rule (zone C rule) to assess special cause variation.¹⁰ We used Student’s *t*-test to compare the delay in minutes from the preintervention period to the postintervention period.

The Institutional Review Board exempted this project from review as quality improvement, and there were no ethical concerns.

RESULTS

The data for this project included 1,981 first cases performed in the pediatric ORs over 75 weeks from May 2018 to October 2019. On-time starts improved from 62% from the baseline to 77% and sustained for 41 weeks (Fig. 3). The center-line shifts occurred due to our interventions at week 20 and then again at week 34.

Before any intervention (weeks 1–11), the estimated average delay for all first cases per week was 197.9 minutes per week. Following the final intervention (weeks 39–75), delays decreased to 133 minutes per week ($P < 0.05$), allowing us to utilize additional 64.9 minutes of OR time. Using a previously quoted figure of \$62 per minute, we estimated our savings per week to be about \$4,023, resulting in potential cost savings of \$209,237 per annum.

DISCUSSION

We report improvement in on-time starts in first cases in the pediatric OR from 62% to 77% using quality

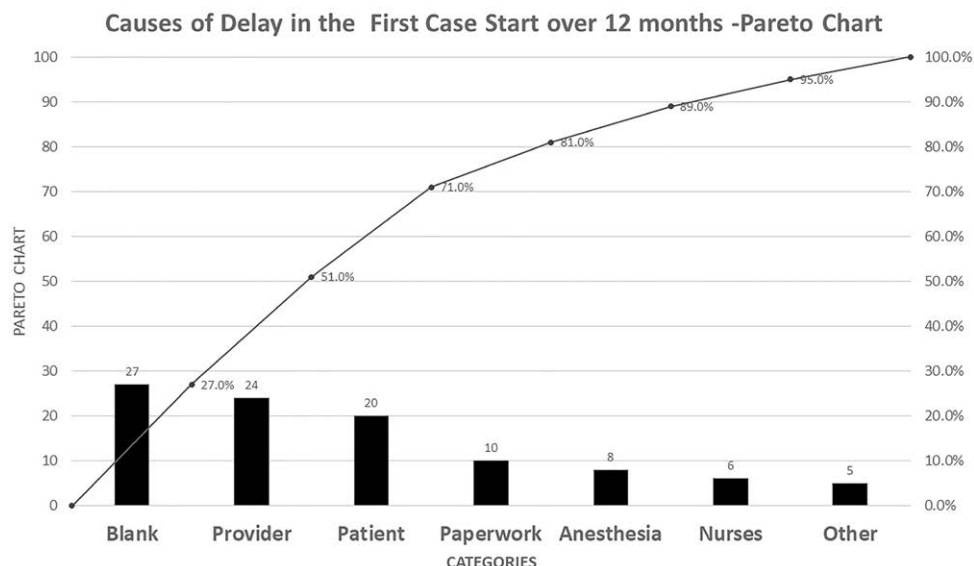


Fig. 1. Causes of delay in the first case start in 12 months before the project start—Pareto Chart.

Key Driver Diagram

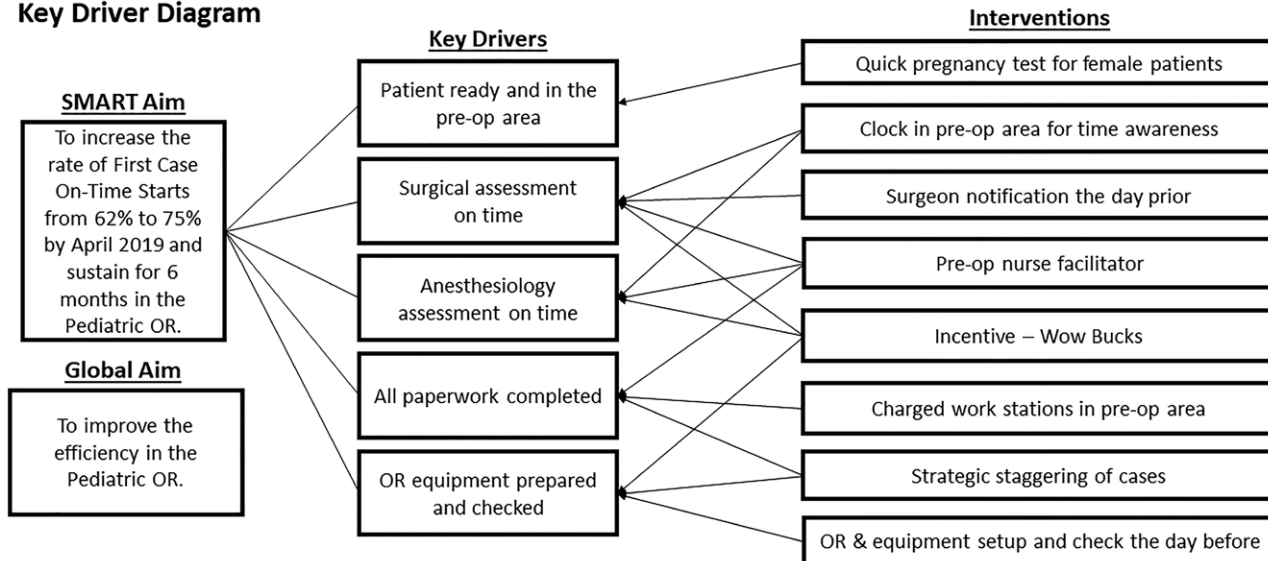


Fig. 2. Key driver diagram showing the aims, key drivers, and interventions.

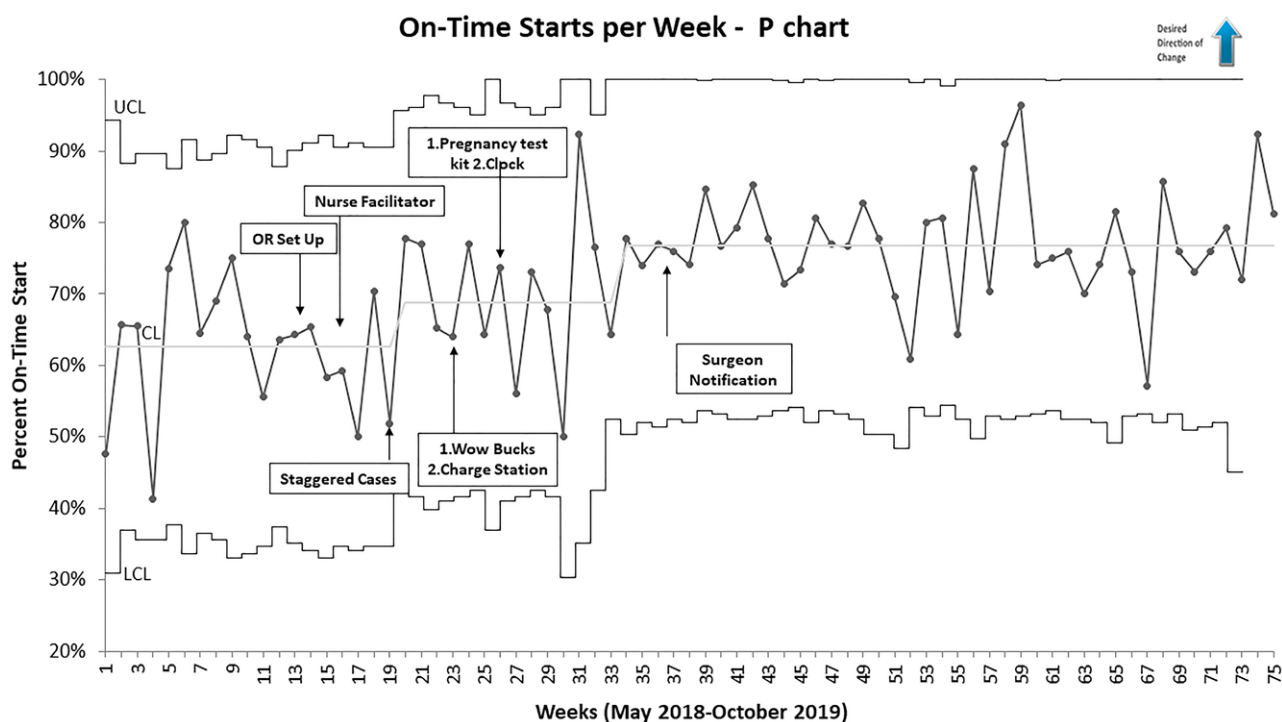


Fig. 3. Statistical process control P chart showing the percentage of on-time starts in 1,981 OR first cases over 75 weeks from May 2018 to October 2019. LCL, lower control limit; UCL, upper control limit.

improvement tools and following a detailed analysis of causes of delays. It is worth noting that in our study of delays, we observed patient-related factors in 20% of cases, which puts a ceiling for our improvement to 80% with interventions mostly aimed at our processes and personnel.

The first case on-time start is one of the commonly measured performance indicators of OR efficiency.^{3,4} Delay in the first case is likely to cause downstream effects

of delays for the whole day in the OR. From the patient perspective, starting their operation on time is essential. It avoids anxiety and dissatisfaction.⁴ Particularly, for pediatric patients, staying *nil per os* for an unnecessarily long time can be a significant source of dissatisfaction. From a surgeon’s perspective, delays in OR cases can be disruptive for other planned clinical activities. For anesthesiologists and other OR personnel, delays in OR may lead to work overtime at the end of the day. For

the hospital, delays in OR mean significant expenses and opportunity costs.

It is difficult to estimate the cost of an OR minute as it depends on the complexity of the surgery and the need for required expert personnel and equipment.¹¹ In one survey of 100 hospitals in 2005, the average operating room fee was \$62 per minute with a range of \$21–\$133.² This fee was separate from the professional charges of surgeons and anesthesiologists. In a 2015 study at the University of California, San Francisco, the authors valued 1 minute of the OR time to be \$53 to \$78.⁴ In 2019, Nationwide Children's Hospital reported a \$1,431 charge for first 15 minutes in the OR and \$410–\$2,921 for every additional 15 minutes in the OR, depending on the complexity level of the case.¹² Using the conservative value of \$62 per minute, we estimated our potential cost savings at more than \$200,000 per annum with low-cost interventions.

Several studies have reported improvement in on-time start rates in ORs, but only a few studies have used quality improvement tools to target key drivers of the delay. In some studies, authors hired additional staff such as a nurse coordinator to focus and improve on-time starts.^{1,9} Other studies used significant financial incentives such as annual bonuses of up to \$2,000 for surgeons for more than 90% on-time starts or an at-risk salary model for anesthesiologists.^{5,6} These interventions require a significant financial investment. The literature on improving on-time starts in the pediatric OR is limited, and there may be additional challenges in this population due to a high level of anxiety and a possible need for more discussion from surgeons and anesthesiologists. One pediatric study from Toronto in 2010 reported an improvement in the first case on-time start from 6% to 60% over 9 months.¹ Interventions included the creation of a task force, assignment of additional staff to the preoperative unit, and introduction of a mandatory huddle to improve communication and to ensure the timely arrival of surgeons and anesthesiologists.¹ The authors noted that the huddle, although successful in leading improvement, was resented by several physicians for the extensive regulations of arrival time.¹ In our study, we used a similar collaborative team-based positive approach to improve our system. Still, we avoided using a specific mandatory time of arrival or huddle to maintain physician satisfaction. We aimed the majority of interventions in our study toward streamlining preoperative processes. Unlike other studies that used significant financial incentives, we gave small incentives in the form of an instant reward of “Wow Bucks” to the entire OR team, which created excitement and talking points amongst the OR personnel.

Our study has some limitations. First, our average baseline on-time start rate was around 62%, already much better than in many other studies where baseline on-time start rates were anywhere from 6% to 49%.^{1,3,5} Although a subsequent improvement to 77% from 62%

seems modest, it is noteworthy that patient-related causes led to 20% delays in our assessment. We did not do any patient-focused interventions, and innovative measures aimed at these issues may drive improvement further. Second, we implemented many interventions over time in our study, so it is difficult to know which intervention was the most effective. We feel that process improvement, including coordination in the preoperative area and staggering of cases to make it easy for all OR personnel, was a critical logistic milestone. Introducing the “Wow Bucks” incentive created an awareness that drove behavioral and cultural change. Another limitation of the study is that we do not know all causes of the delays in our OR as the nurses left the cause of the delay field “blank” in 27% of the cases. Finally, we do not have exact data on actual first case “surgery start” time, or the first case finish time or whether we were able to perform additional cases with improvement in on-time starts.

CONCLUSIONS

In conclusion, we improved on-time start in the pediatric ORs from 62% to 77% without using any significant financial resources. We believe that our interventions can be used in other children's hospitals and are likely to produce a similar impact. Improving on-time starts has positive implications for patients, providers, OR personnel, and hospital finances.

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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